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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 040424

Application Number: 09/528,262
Filing Date: March 17, 2000
Appellant(s): DEN BAARS ET AL.

Jaye G. Heybl
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 3/12/2004.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is substantially correct. The changes are as follows:

Upon further reconsideration, the rejections of claim 9 are withdrawn, and the claim is allowed. The prior art teaches that it was known to use UV light emitted from overlying LEDs to pump $Cr:Al_2O_3$ (ruby) substrates or crystals (*see e.g.*, JP '203 and Kaneko '901). Kaneko also teaches that *yellow*-emitting LEDs can pump crystals that re-emit red light; but no specific examples set forth therein use yellow light to pump ruby crystals. Further, it was known at the time of the invention that ruby has a large photon absorption cross-section for yellow light (around 550 nm) as well as a larger absorption cross-section for UV light (*see e.g.*, Powell, Physics of Solid-State Laser Materials, 1998, page 239, FIG 6.7). However, a search of the relevant art failed to disclose or provide a reasonably specific motivation for pumping ruby particularly with a yellow LED—as opposed to pumping ruby with a UV LED.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is substantially correct. The changes are as follows:

a. Appellant's brief presents arguments (*see* item "a" of the ISSUES section and corresponding argument (1) of ARGUMENT section b) relating to whether claim 37 is in improper dependent form under 37 CFR 1.75(c) for failing to further limit the subject matter of parent claim 30. This issue relates to petitionable subject matter under 37 CFR 1.181 and not to appealable subject matter. See MPEP § 1002 and § 1201. The examiner's objection to claim 37 is temporarily withdrawn and suspended until resolution of the present appeal determines whether the subject matter of claim 37 is patentable on the merits, and thereby determines whether this objection to the claim's form is moot.

b. Appellant's brief presents arguments relating to whether claim 39 is properly rejected under 35 USC §112, first paragraph (*see* item "b" of the ISSUES section and corresponding argument (2) of ARGUMENT section b). This rejection was made by the examiner to clarify for the record, the manner by which this claim's embodiment operates. As Appellant's response has clarified the issue, the 112-1st paragraph rejection is hereby withdrawn.

c. In the final rejection, claim 41 was inadvertently omitted from the list of claims that are anticipated by Kaneko. However, because claim 41 is so similar in substance to rejected claim 14, and because claim 41 is broader than rejected claim 42, the examiner believes that no additional issues are raised by the further inclusion of this claim within the Kaneko rejection.

Further, Appellant has neither asserted that—nor argued any basis for why—claims 14, 41 or 42 are separately patentable.

d. The issues related to the rejections of claim 9 (issues f and g, and corresponding arguments 6 and 7) are mooted by the withdrawal of the rejections and allowance of the claim, as discussed above.

(7) Grouping of Claims

The rejection of claims 4-7, 14, 15, 24, 30, 31, 33-42, 46, 47, 54 and 55 stand or fall together because appellant's brief does not include a statement that this grouping of claims does not stand or fall together and reasons in support thereof. See 37 CFR 1.192(c)(7).

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

JP 10-56203	MATSUMOTO et al.	2-1998
6,239,901	KANEKO	5-2001
5,684,309	McINTOSH	11-1997
5,898,185	BOJARCZUK, JR. et al.	4-1999

Full English translation of JP 10-56203 that was performed by the USPTO translation branch (attached), superceding the prior, DERWENT machine translation and Appellant's partial translation.

(10) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

1. Claims 5-7, 14, 24 and 41 are rejected under 35 U.S.C. 102(b) as being anticipated by JP '203. (All references to the JP '203 patent document are based upon the attached, full English translation.)

a. Regarding claim 14, JP '203 discloses (see e.g., [0009] and [0022] and FIGs 1, 3 and 4) a double heterojunction light emitting diode 22 (FIG 3) having:

- a light emitting layer or "active region" 26;
- a pair of oppositely doped layers (n-doped AlGaN 25 and p-doped AlGaN 27) on opposite sides of said active layer which cause said active region to emit light at a predetermined wavelength in response to an electrical bias (applied by n- and p-electrodes 30 and 29) across said doped layers; and
- a doped substrate 21, said active region and doped layers disposed successively on said substrate such that said substrate absorbs at least some of said light 32 from said active region 26; and

concerning the final limitation—"said substrate doped throughout with a plurality of impurities such that said impurities simultaneously absorb the light of said active region and each re-emits a respective color of light"—see e.g., paragraph [0023] (underline added):

> When UV light (32) passes through substrate (21), it is converted to visible light (33) of <u>any of red, green, and blue color</u> by means of transition element (light emitting centers), and the visible light is emitted from the opposite surface and side surface of substrate (21).

Also see [0010] (underlines added):

> As said substrate (2), a transparent hard substrate doped with an element (light emitting center element), which receives the UV light (wavelength in the range of 250-410 nm) emitted from semiconductor light-emitting element (3) and generates light of red, green, or blue color, is used... <u>The light emitting center elements that can be added in said substrate base material are elements that are dispersed **homogeneously** in said base and can change the UV light emitted from semiconductor light-emitting element (3) to any color of red, green, and blue for emission. For example, **one or several types** selected from the following transition elements may be doped: Cr, Ti, Fe, V, Cu, rare earth elements (Sc, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu), Y, and other transition elements.</u>

and paragraph [0014] (underlines added):

> For said light-emitting element (1), as substrate (2), one may adopt at least one type selected from the following group: sapphire doped with **at least one** type of transition element, YAG or GGG doped with at least one type of transition element, beryl doped with at least one type of transition element, silicon carbide doped with at least one type of transition element, spinel doped with at least one type of transition element, $LiYF_4$ doped with at least one type of transition element, magnesia doped with at least one type of transition element, and glass doped with a transition element. In this way, one can form semiconductor light-emitting element (3) on substrate (2) using MOCVD method or the like, and perform heat treatment. Also, because said materials have a high transmissivity for UV light (4) and visible light (5), it is possible to reduce the loss as UV light (4) is converted to visible light (5). Also, as substrate (2), a sapphire substrate containing **at least one type** selected from the group of Cr, Fe, Ti, V, Cu, and rare earth elements is used. As a result, it is possible to form semiconductor light-emitting element (3) having a light emitting layer made of any of GaN, $Al_xGa_{1-x}N$ (where $X \leq 0.4$), $In_yGa_{1-y}N$ (where $y \leq 0.1$), ZnS, diamond, etc. in good state on substrate (2). Also, for light-emitting element (1), by setting a portion that can emit at least any color of red, green, and blue with the light emitted from semiconductor light-emitting element (3), it is possible to use it as a color display light-emitting element.

At least these passages of JP '203 expressly disclose that plural, distinct impurities that re-emit different colors of light may be doped throughout the substrate. Claim 4 of the reference further recites, "the substrate has **a portion** that emits **at least one of red, green, and blue color** with the light emitted from said semiconductor light-emitting element." This claim indicates that the plural types of impurities may be provided—not only in different portions of the substrate—but also within the same region of the substrate.

b. Regarding claims 5-7, paragraph [0010] cites multiple candidates for the substrate composition, including various compositions set forth in claim 5. Also, the examples employ a sapphire substrate (e.g., [0026]). Paragraph [0010] also states that the substrate dopant impurities may be composed of transition elements, expressly including

all of the elements cited in claims 6 and 7.

c. Claim 24 is anticipated by JP '203 according to the well-established product-by-process doctrine because this is a product-by-process claim, and the recited methods of doping do not further distinguish the final structure.

d. Claim 41 is similar to claim 14, substituting "active layer" for "active region;" and "arranged in a stack on said substrate" for "disposed successively on said substrate." The grounds of rejection are the same.

2. Claims 4-7, 14, 15, 24, 41 and 42 are rejected under 35 U.S.C. 102(e) as being anticipated by Kaneko '901.

Kaneko discloses AlGaInN-based (or III-N) emitters, such as light emitting diodes (LEDs) and laser diodes (LD) (col. 4, lines, 43-47), formed on an "optical crystal substrate" that is doped with impurities (e.g., col. 4, lines 60-62). For example, the optical crystal substrate may be ruby—which is sapphire doped with Cr^{3+} impurities, or $Al_2O_3{:}Cr^{3+}$ (e.g., col. 4, lines 43-45). The "optical crystal" or impurity-doped substrate absorbs a primary wavelength (or "pumping light") in the range of 400-550 nm (UV-yellow) from the overlying semiconductor LED's III-N materials (or active region) (col. 4, line 23; col. 5, line 7), and re-emits a second wavelength from the doped substrate which is different/longer than that emitted from the primary LED source.

The substrate may emit more than one wavelength (col. 10, lines 11-15). These wavelengths may or may not include the wavelength of the pumping light (the light from the LED or LD that pumps the substrate activator centers) (col. 10, lines 29-36). The semiconductor substrate may be of various materials including sapphire (col. 3, lines 10-15). **The substrate**

may be uniformly doped with a plurality of dopants (col. 3, lines 15-20). Various wavelengths including white light can be selectively generated (i.e., R,G,B or Y,B) (col 3, lines 45-50; col. 10, lines 30-36). Regarding claim 42, various dopants or activators may be employed including Cr, Ti and Co (col. 3, line 15), which emit red, green and blue respectively. The invention may be employed for a variety of applications including display devices (col. 3, lines 45-50).

3. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over JP '203 as applied to the claims above. The reference states that various conventional UV sources may be employed including LEDs and lasers. The reference further expressly discloses a double heterojunction LED having a single light emission layer (e.g., [0022]) may be employed. Regardless of whether the recitation of a double heterojunction LED is synonymous with a single quantum well (SQW) LED, it was well known to those of ordinary skill in the art at the time of the invention to form GaN-based LEDs so as to have either SQW or MQW active layers, and it would have been obvious to those persons to have employed either, depending only upon well-known design considerations such as the trade-offs in manufacturing costs and desired light output, or the specific bandgap desired and the ease of producing the specific bandgap with the particular active layer design.

4. Claims 15 and 42 are rejected under 35 U.S.C. 103(a) as being unpatentable over JP '203 as applied to the claims above, and further in view of Kaneko '901 as applied to the claims above. JP '203 teaches that plural types of rare earth or transition metal elements may be doped

throughout the substrate as dopant light emission centers (e.g., [0010]). JP '203 further sets forth specific examples of Cr and Ti (which emit red and green light from sapphire, respectively) (e.g., [0010]), but does not expressly disclose that the particular transition metal, Co (which emits blue), may be employed for the color (R,G,B) display.

a. Kaneko discloses various III-N LED and LD emitters formed on activator-doped semiconductor substrates for absorption of a primary wavelength in the range of 400-550 nm (UV-yellow) for III-N materials (col. 4, line 23; col. 5, line 7), and re-emission of a second wavelength from the doped substrate which is different/longer than that emitted from the primary LED source. The emitter may emit more than one wavelength (col. 10, lines 11-15). These wavelengths may or may not include the wavelength of the pumping light (the light that pumps the substrate activator centers) (col. 10, lines 29-36). The semiconductor substrate may be of various materials including sapphire (col. 3, lines 10-15). **Various dopants or activators may be employed including Cr, Ti and Co (col. 3, line 15).** The substrate may be uniformly or non-uniformly doped and a plurality of dopants can be utilized (col. 3, lines 15-20). **Various wavelengths including white** (i.e., B,G,R or B,Y) light can be selectively generated (col 3, lines 45-50; col. 10, lines 30-36).

b. It would have been obvious to one of ordinary skill in the art at the time of the invention to have particularly employed Co for one of the emission centers in the JP '203 sapphire substrate as taught by Kaneko because Kaneko teaches that the use of Co:sapphire was a known functional equivalent for re-emitting blue light; and for any of various reasons such as (1) business reasons relating to the specific cost or availability of Co relative to other blue activators specifically recited by JP '203; (2) to obtain the specific emission wavelength and

spectral width of Co, as desired based upon the intended particular lighting application; or (3) to obtain white light as taught by Kaneko.

5. Claims 30, 31, 33-40, 54 and 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over either JP '203 or alternatively JP '203/Kaneko as applied to the claims above, and further in view of McIntosh '309. As was explained above, JP '203 teaches UV LEDs formed on doped substrates that cause secondary light re-emission. Kaneko discloses the LED can be composed to emit anywhere between UV and yellow. Neither reference teaches LEDs having multiple, stacked layers capable of emitting more than one color of primary light.

a. McIntosh teaches stacked III-N LEDs having two or more quantum-well InGaN active layers that have the respective In concentrations set to emit various combinations such as blue and yellow, respectively, or B,G,R respectively. Various embodiments depict multiple contacts for selective bias of one, some, or all of the active layers to emit any desired combination of the colors. The barrier layers interposing the active layers may be p-doped (e.g., col. 3, lines 1-6). McIntosh does not teach the use of a doped substrate for secondary re-emission.

b. It would have been obvious to one of ordinary skill in the art at the time of the invention to have to have combined the teachings of JP '203 or JP '203/Kaneko with those of McIntosh so as to provide a multi-color LED that emits some plural number of the desired light wavelengths from the III-N semiconductor active layers (McIntosh), and the other one(s) of the desired wavelength(s) from the doped substrate on which the active semiconductor layers are formed (JP '203 and/or Kaneko) for the purpose of simultaneously enabling: independent color

control for a full color display; reducing the lateral space requirements by not requiring separate side-by-side substrate-dopant color centers; and simplifying the manufacturing process and associated cost that would otherwise be associated with growing all three InGaN active layers and selectively etching the layers for making appropriate electrical contacts.

i. Further, it would have been specifically obvious to have employed an LED that emits UV, B and G primary light on a red re-emitting ruby (Cr:Al203) substrate because AlN and GaN have relatively close lattice constants while InN has a lattice constant that is not close to AlGaN. Restated, the formation of LEDs having active layers that include small amounts of In (for producing UV to green LEDs) is a relatively mature technology, but forming large In-content InGaN LEDs (for red emission) has historically presented significant problems including (1) lattice-mismatch, (2) In clustering or pooling, and (3) dissimilar requisite (lower) growth temperatures than (Al)GaN formation; the technology addressing these problems is not as mature. Thus, it would have been obvious to have specifically employed an LED emitting UV, B and G on a red emitting substrate for the purpose of avoiding the problems associated with growing large In content InGaN active layers that arise when trying to grow a red semiconductor emitter.

ii. Regarding claim 40, it was known to produce white light from the two complementary colors of blue and yellow. Nichia Co. has been doing this since the mid 1990s. (See Appellant's admission in the Background of the Invention, page 2). Also, McIntosh discloses using two or more layers to produce desired colors including white (e.g., FIG 5 and cols. 5 and 6). Also as was explained previously, Kaneko teaches that

UV to yellow LEDs can cause secondary re-emission of red light from doped substrates. It would have been obvious to employ a blue/yellow on a red re-emitting substrate for the purpose of obtaining pink light or a white light that has a warmer hue.

6. Claim 47 is rejected under 35 U.S.C. 103(a) as being unpatentable over JP '203/McIntosh or alternatively JP '203/Kaneko/McIntosh as applied to the claims above, and further in view of Bojarczuk, Jr. et al. '185.

a. The combination of JP '203 (/Kaneko) and McIntosh teach all of the limitations of claim 30. Irrespective of whether JP '203 or Kaneko further enable the specific details of how to arrange and connect plural devices in an array, they at least suggest this general goal or desire. McIntosh further teaches how to electrically connect the various semiconductor layers for at least one, individual LED stack. These base references do not appear to further, expressly disclose any arguably conventionally-known schemes for integrating electrical circuitry with the LED on a common substrate.

b. Bojarczuk teaches a plurality of blue or UV-LEDs which are arrayed on a common light-emission substrate. See e.g., FIG 8 wherein LEDs are formed on a light emission substrate 72 and connected/integrated with circuitry on a common, Si-device-driver substrate 86. The LED is etched to form trenches that extend downward partially into the n-side layer 74 to isolate the active and p-side layers of the individual LED segments in the array. Each of the layers desired to be electrically contacted is electrically interconnected to the driver substrate: the n-side layer 74 is contacted by a common contact 84/88, and each region of the p-side layer is contacted by separate p-side contacts 82/90. UV light is emitted selectively from the three

portions of the LED to be absorbed by secondary B,G,R color-emission centers 94,96,98 formed therebelow. The reference states that the embodiment of FIG 8 is a full-color display (col. 5, lines 31-33); restated, each of the three p-side portions of the LED may be selectively biased independently. Otherwise, a full color display could not be achieved.

c. It would have been obvious to one of ordinary skill in the art at the time of the invention to have included within a color array as taught by the JP '203/Kaneko/McIntosh, a common substrate with integrated electrical circuitry as taught by Bojarczuk for the purpose of better integrating the device's components.

8. Claim 46 is rejected under 35 U.S.C. 103(a) as being unpatentable over either JP '203/McIntosh or alternatively JP '203/Kaneko/McIntosh as applied to the claims above, and further in view of Appellant's prior art admissions. As was explained above and in previous Office Actions, employing yellow down-converting phosphors was known. Appellant acknowledges this fact. It would have been obvious to one of ordinary skill in the art at the time of the invention to have employed any combination of LED active layers, down-converting phosphor-doped encapsulants and/or substrate dopants, the specific combination chosen depending only upon conventional considerations such as the respective manufacturing limitations and costs and the resultant lifetime associated with each option.

(11) Response to Argument

Argument (1):

Appellant's argument relating to the dependent form of claim 47 is mooted by the

temporary withdrawal and suspension of the claim objection.

Argument (2):

Appellant's argument is mooted by the withdrawal of the 112-1st paragraph rejection.

Argument (3):

Appellant first argues that JP '203 does not anticipate the claims. Appellant acknowledges that JP '203 does disclose UV-emitting LEDs formed on substrates that are, in turn, doped throughout with a species of impurities that may re-emit, for example, red, green *or* blue (R, G, or B) light. Appellant disputes that the reference further discloses the additional option of doping the substrate throughout with plural species of R, G, and B emitting impurities instead of only a single species of impurities.

Specifically, Appellant argues that "the examiner failed to show where this limitation is found in HP '203 and instead, the examiner relied on a stream of references that do not address this limitation."[1] (page 12 of Appeal Brief, first full paragraph.) However, Appellant subsequently proceeds to contradict his assertion that the examiner failed to show where this limitation is found. In page 15 of the Appeal Brief, Appellant acknowledges,

> To support his conclusion that JP '203 shows the elements of the rejected claims that the examiner cited Paragraph 10 of JP '203 as follows:
>
> > ...The light-emission center element added to the substrate base material is an element, that <u>when uniformly distributed throughout the base</u> emits light of the color, red, green, or blue when [exposed to] ultraviolet emitted by semiconductor light-emitting element 3; <u>examples are one, or two or more, [elements]</u> selected from transition elements such as Cr, Ti, Fe, V, Cu, the rare earth elements...and Y. (emphasis added by examiner)

[1] It should be noted that the examiner's citation of a "stream of references [to various portions of JP '203] that do not address [the plural dopants] limitation" were included for other reasons, such as (1) to address other limitations appearing either in that or other claims; and (2) to point out the support or bases for the motivation-to-combine that was used for other, dependent claims that were rejected under 35 USC 103 as obvious.

He then combined Paragraph 10 with Paragraph 14, which provides as follows:

> ...By employing as substrate 2 a sapphire substrate containing at least one of element selected from the group consisting of Cr, Fe, Ti, V, Cu, and rare earth elements, becomes possible to produce on substrate a satisfactory semiconductor light-emitting element 3 comprising a light-emitting layer of [GaN-based materials...] or the like. (emphasis added by examiner)

Please note that these passages cited by the examiner in the final Office Action of 11/12/2003 (paper #28) were taken from the partial translation that was previously supplied *by the Appellant.* (See the REMARKS section of paper #23, dated 4/21/2003, page 9 wherein Appellant stated, "[t]he examiner provided a Derwent computer translation of this reference with his office action, but Applicants found the translation difficult to follow leaving the true scope of the reference unclear. Applicants had relevant portions of the reference translated by a professional translating service and a copy of the translation is attached for the examiner's reference.)[2] As such, Appellant's partial translation—as well as the USPTO translation branch's full translation attached hereto—supports the examiner's position that JP '203 discloses that the substrate may be doped throughout with plural dopants.

Appellant nonetheless asserts that paragraph 10 of JP '203 only teaches that the substrate JP '203 may be doped with one species of impurity because Appellant's translation states that "the base emits light of the color, red, green or blue" and that this is consistent with the illustration ins JP '203 that show devices having substrates emitting a single color of light. This argument is not persuasive.

Paragraph 10 states, "...The light emitting center elements that can be added in said

substrate base material are elements that are dispersed homogeneously in said base and can change the UV light emitted from semiconductor light-emitting element (3) to any color of red, green, and blue for emission. For example, one or several types selected from the following transition elements may be doped: Cr, Ti, Fe, V, Cu, rare earth elements (Sc, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu), Y, and other transition elements." (emphasis added by examiner.) The second sentence unambiguously states that either one or alternatively plural types of dopants may be employed as the homogenously dispersed elements.

Appellant has not asserted that this second sentence has any other plausible meaning. Rather, Appellant argues that JP '203 should be interpreted as only disclosing a single type of substrate dopant because this interpretation is consistent with the drawings. However, the fact that JP '203 discloses other embodiments—wherein the substrate is doped with only one impurity—does not detract from the fact that the reference also discloses that the substrate may be doped with plural types of dopants. Moreover, it is immaterial whether the drawings only depict certain embodiments wherein the substrate is doped with a single type of impurity. Appellant has cited no legal authority for his assertion that only depicted portions of a reference can serve as prior art. This is simply not the law.

Appellant also argues that even if JP '203 does teach all of the elements (i.e., the substrate doped throughout with plural types of impurities), the reference is not sufficiently enabled. Appellant's primary basis for this assertion was that particular portions of the previously-supplied, Derwent machine translation of the reference were unclear. This argument is mooted by the inclusion of the attached non-machine full English translation.

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[2] This partial translation provided by Appellant is listed in the Office's eDAN system as an NPL document dated 11/20/2002.

Appellant also argues that JP '203 provides no guidance for providing the claimed invention having plural types of impurities doped throughout the substrate, nor any working examples. As was explained hereinabove though, JP '203 does provide the ordinarily skilled artisan more than reasonable guidance on how to make the invention as claimed; it discloses that plural (one or more) impurities may be doped throughout the substrate to obtain the desired emission color.

Further, Appellant acknowledges that JP '203 is enabled for at least teaching a substrate doped throughout with a single type of light-emitting impurity. Appellant only argues that the reference is not enabled for a substrate having plural types of such dopants. However, Appellant has provided absolutely no bases nor evidence for why the ordinarily skilled artisan who is able to dope such a substrate with a single species of impurity would not be equally able to dope the substrate with plural species of the disclosed impurities.

Argument (4):

This argument section relates to the anticipation rejection of claims 4-7, 14, 15, 24, 41[3] and 42 over Kaneko '901. Appellant first argues:

> [Kaneko] has been repeatedly cited by the examiner to reject various claims through our prosecution of the present application. Applicants have been required to meet these rejections with repeated arguments as to why the rejections are improper, some of the same arguments being presented below. In response to the applicant's arguments through prosecution the examiner withdrew his 35 U.S.C. 102 rejections based on this reference and instead relied on it to make 35 U.S.C. 103 rejections. However, in his final office action the examiner, for unknown reasons, changed his position and again asserted a 35 U.S.C. 102 rejection based on this reference. It has been this type of seemingly complete changes in the examiner's position that has contributed to the convoluted and

[3] In the final Office action, claim 41 was inadvertently omitted from the listing of claims that were rejected as anticipated by Kaneko. See the ISSUES section of the Examiner's Answer, *supra*, for an explanation of why the further inclusion of claim 41 in this rejection does not raise any additional issues.

confusing prosecution of this case. (page 17 of the Appeal Brief, first paragraph.) This argument does not address the merits of the rejection, but is addressed to clarify the record.

As was explained in the rejections, Kaneko discloses LEDs formed on substrates. The LED may emit various wavelengths from UV to yellow. The substrate may be doped throughout with plural types of impurities that absorb the LED's "pumping" light and re-emit a secondary color(s) of longer wavelength (e.g., red). The substrate further includes mirrors that further produce an optical cavity in the substrate and cause the light emitted from the substrate to be emitted coherently or directionally.

Appellant's claims originally did not require that the light emitted from the substrate be emitted omnidirectionally (as is the case in JP '203 wherein the additional substrate mirrors are not employed). As such, the claims were broad enough to warrant the anticipation rejection over Kaneko. Appellant amended the claims to require omnidirectional light emission from the substrate, thereby requiring the examiner to withdraw various 102 rejections based on Kaneko. Appellant later deleted this limitation from various claims by subsequent amendment (e.g., independent claims 14, 41 and 42), thereby broadening these claims and necessitating the reinstatement of this rejection. As such, the reasons for the examiner's change in position is not "unknown" as alleged by Appellant. Rather, the examiner's changes in position—and any associated convolution or confusion during the prosecution—is based upon Appellant's decisions to narrow and subsequently broaden various claims.

Turning to the arguments that are directed to the merits, Appellant argues that the examiner has failed to meet his burden of showing that Kaneko anticipates the claims because the examiner did not show where Kaneko discloses the substrate (or optical crystal) being doped

with plural types of light-emitting impurities. In fact, the rejection did explain where Kaneko discloses all of the claimed elements. Regarding this specific limitation argued, the final rejection stated, *inter alia*, "...The semiconductor substrate may be of various materials including sapphire (col. 3, lines 10-15). Various dopants or activators may be employed including Cr, Ti and Co (col. 3, line 15).[4] **The substrate may be uniformly** or non-uniformly **doped and a plurality of dopants can be utilized (col. 3, lines 15-20).**" (Final Office Action; paper #28, paragraph 5a; emphasis added)

Appellant next argues that the present invention is different from Kaneko's because Kaneko's doped substrate further includes mirrors that produce an optical cavity an emit coherent/directional light, whereas Appellant's substrate does not include mirrors and emits light omnidirectionally. However, the omission of the substrate mirrors (or omnidirectional light emission) is nowhere recited in the rejected claim(s). Rather, the rejected claims employ the open-ended transition word, "comprising." Thus, these claims are broad enough to read on a structure that either (1) possesses substrate mirrors and emits light directionally; or alternatively (2) omits the substrate mirrors and emits light omnidirectionally. Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Argument (5):

This argument section does not set forth any additional arguments, but only asserts allowability of claim 4 based upon the claim's dependency from claim 14 discussed above. As such, claim 4 stands or falls with claim 14.

[4] Kaneko and Appellant's specification disclose that Cr, Ti and Co can emit red, green and blue, respectively.

Argument (6):

Argument 6 is moot because the rejection of claim 9 has been withdrawn and the claim is allowed.

Argument (7):

The portion of argument 7 relating to claim 9 is moot. The portion of Appellant's argument 7 relating to claims 15 and 42 is not persuasive for the reasons set forth hereinbelow. It is also noted for the Board's convenience that because these claims were also rejected as being anticipated by Kaneko '901, the Board's affirmance of that anticipation rejection would render moot the obviousness rejection of JP '203 in view of Kaneko, and therefore render moot argument 7, which is directed towards this rejection.

Turning to the merits of this argument section, Appellant argues that JP '203 is not enabled. This argument was addressed hereinabove. Appellant also argues that Kaneko further adds mirrors to the substrate. This argument is moot: only claim 9—but not claims 15 and 42—recited omnidirectional emission. The only issue is whether it have been obvious for one of ordinary skill in the art at the time of the invention to have used Co as the blue-emitting impurity (as taught by Kaneko) instead of various other conventional blue-emitting impurities that were taught by JP '203.

JP '203 discloses that the substrate may be doped throughout with plural types of impurities emitting red (e.g., Cr), green (e.g., Ti) and blue, respectively, but does not expressly disclose that Co, in particular, may be the impurity that emits the blue light. Kaneko teaches that it was known to employ Co in the same environment (a sapphire substrate) for the same purpose (to re-emit blue light). Restated, Kaneko teaches that Co was a known substitutional equivalent

for the other blue-emitting impurities (see MPEP 2144.06). Moreover, the final rejection additionally set forth further motivation for selecting this particular species of conventional blue emitting dopant (including business reasons, and issues relating to desired hue and spectral width).

Appellant argues that the examiner did not cite a disclosure or suggestion that these references could be so combined. In fact, JP '203 and Kaneko both discuss the motivation of employing impurities that emit red, green and blue light generally; and Kaneko teaches the specific use of Co for this particular application. As such, Kaneko does provide motivation for using the substitutional equivalent, Co. Also, the additional reasons stated by the examiner provide further suggestions for using Co. Appellant has made no arguments as to why Co would provide any non-obvious nor unexpected results. Also, Appellant has made no assertion that the additional motivations stated by the examiner were incorrect, nor that the well-accepted scientific principles upon which they were based were faulty. As such, the examiner has made a *prima facie* showing of obviousness, and Appellant has not met his burden to rebut this *prima facie* showing. As such, the rejection should be affirmed.

Argument (8):

The claims addressed in this argument section are directed towards an embodiment of Appellant's invention that is different than the embodiments discussed above. (*See e.g.*, FIG. 2 of the present application's drawings.) In this embodiment, *as disclosed*, plural LED active layers stacked on the substrate emit various colors (e.g., UV, blue and green, respectively). The substrate, being ruby, is doped with a single impurity: ruby is Cr-doped sapphire or $Cr{:}Al_2O_3$. Ruby has a large photon absorption cross-section for UV wavelengths, but a small absorption

cross-section for blue and green wavelengths: i.e., the ruby substrate will emit red light when it absorbs UV light, but it will not emit significant light when it absorbs blue or green light. By selectively biasing the desired electrodes (27, 28, 29, 31), the active layers can be caused to produce UV, G or B light, either individually or in any desired combination. As such, the active layers in combination with the ruby substrate can ultimately emit any one of R (and UV), G and B, combinations thereof, or all three (i.e., white light).

Being directed towards this embodiment, the relevant claims of this argument section (claim 30 and its dependents) are broader than the previously discussed claims: the present claims do <u>not</u> require that the substrate possess plural types of dopants. These claims also do <u>not</u> require that the substrate be doped throughout uniformly. Rather, claim 30 only require that the substrate is "a doped substrate" and that "said substrate absorbing at least some of said light from at least one of said plurality of active layers and re-emitting light at a different wavelength."

Accordingly, Appellant's reiteration of the argument—that JP '203 does not teach a substrate doped throughout with plural types of impurities—has no bearing on the rejection of the present claim set. Appellant also argues that the 103-obviousness rejection is improper by arguing the JP '203 and McIntosh references separately. Specifically, Appellant argues that McIntosh (disclosing stacked LED active layers) does not teach a doped substrate, and that JP '203 (disclosing a substrate doped with at least one impurity) does not teach an LED with multiple active layers. It is well-settled that one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Appellant also alleges that "[t]he examiner has not provided a reference that teaches or suggest that these reference could or should be combined." In fact, the final rejection provided ample motivation to combine JP '203 and McIntosh. See e.g., paragraph 10.b of the final rejection (numbered in the Grounds of Rejection section hereinabove as 5.b):

> b. It would have been obvious to one of ordinary skill in the art at the time of the invention to have to have combined the teachings of JP '203 or JP '203/Kaneko with those of McIntosh so as to provide a multi-color LED that emits some plural number of the desired light wavelengths from the III-N semiconductor active layers (McIntosh), and the other one(s) of the desired wavelength(s) from the doped substrate on which the active semiconductor layers are formed (JP '203 and/or Kaneko) for the purpose of simultaneously enabling: independent color control for a full color display; reducing the lateral space requirements by not requiring separate side-by-side substrate-dopant color centers; and simplifying the manufacturing process and associated cost that would otherwise be associated with growing all three InGaN active layers and selectively etching the layers for making appropriate electrical contacts.
>
> i. Further, it would have been specifically obvious to have employed an LED that emits UV, B and G primary light on a red-re-emitting ruby (Cr:Al203) substrate because AlN and GaN have relatively close lattice constants while InN has a lattice constant that is not close to AlGaN. Restated, the formation of LEDs having active layers that include small amounts of In (for producing UV to green LEDs) is a relatively mature technology, but forming large In-content InGaN LEDs (for red emission) has historically presented significant problems including (1) lattice-mismatch, (2) In clustering or pooling, and (3) dissimilar requisite (lower) growth temperatures than AlGaN formation; the technology addressing these problems is not as mature. Thus, it would have been obvious to have specifically employed an LED emitting UV, B and G on a red emitting substrate for the purpose of avoiding the problems associated with growing large In content InGaN active layers.

JP '203, itself, further supports the motivation set forth in the above-cited paragraph 10.b.1 for why the skilled artisan would have desired to combine the teachings of JP '203 and McIntosh. While McIntosh teaches that the it was known how to set the In concentration of InGaN sufficiently high so as to produce an LED active layer that emits red light, JP '203 indicates that this development in the technology was still emerging and may possess difficulties.

Specifically, JP '203 discusses the more conventional InGaN-based LED art, explaining that it was known how to employ relatively lower In concentrations in the active layers to produce UV to green light, but that it was not widely known (at least by those inventors) how to set the In concentration to levels high enough to emit red light. (*see e.g.*, JP '203 paragraph [0003]).

To summarize, the examiner set forth a *prima facie* case of obvious, and the burden has shifted to Appellant to rebut it. For the reasons set forth above, Appellants arguments do not overcome this *prima facie* showing of obviousness. Accordingly, the rejection should be affirmed.

Arguments (9) and (10):

These sections do not set forth any additional arguments, but only assert allowability of claims 47 and 46 based upon the claims' dependencies from claim 30 discussed. As such, these claims stand or fall with claim 30.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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PRIMARY EXAMINER

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